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OHIO RIVER POLLUTION SURVEY: INDUSTRIAL WASTE GUIDES

Public Health Service
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1942

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OHIO RIVER POLLUTION SURVEY

FINAL REPORT
TO THE
OHIO RIVER COMMITTEE

SUPPLEMENT "D"

INDUSTRIAL WASTE GUIDES

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
CINCINNATI, OHIO
1942

NATIONAL TECHNICAL
INFORMATION SERVICE

INDUSTRIAL WASTE GUIDES

Supplement "D" to
Final Report to the Ohio River Committee
Ohio River Pollution Survey

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
OFFICE OF STREAM SANITATION
CINCINNATI, OHIO
1942

I

INDUSTRIAL WASTE GUIDES

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Survey Authorization

The Ohio River Pollution Survey, recently completed, was authorized by the Congress to cover the Ohio River and its tributaries, with the specific instructions:

(1) "... to ascertain what pollutive substances are being deposited ..." and

(2) to make the survey "... with a view of determining the most feasible method of correcting and eliminating the pollution ..."

In considering industrial wastes, these instructions have required, first, a determination or estimate of the strength and quantity of each industrial discharge and, second, a determination of indicated treatment or other corrective measures with estimate of cost to apply to each of these discharges. With a total of 1,800 waste-producing industrial plants in the basin, the assignment has been a work of considerable magnitude.

Description of Guides

An essential step in the work has been the preparation of the Industrial Waste Guides, which summarize information available on pollution problems connected with the various classes of industrial establishments found in the Ohio River Basin. Characteristic features of the guides, which are all prepared along similar lines, include:

(1) An "Abstract" giving, in brief form, the essential features of the guide.

(2) "Description of Process" covering the various principal operations in the industry.

(3) "Raw Materials and Products" enumerating these items and giving quantity relationships including number of employees.

(4) "Sources and Quantities of Wastes" discussing waste-producing operations and estimating quantities from individual processes and the total industry.

(5) "Character of Wastes" presenting analytical results of individual process wastes and the total composite wastes, and discussing important characteristics of each waste.

(6) "Pollution Effects" discussing principal objections to discharge of each waste to streams.

(7) "Remedial Measures" discussing corrective measures involving steps within the plant such as recovery practice and disposal of waste materials other than to the sewer, as well as treatment practiced or in various stages of development. Cost data, when reliable, are included in some cases.

(8) "Bibliography."

(9) "Note-Taking Form" as used in the field in collecting data from industrial plants.

(10) "Inspection Report" such as is prepared by the field engineer from the data on the note-taking form and other notes.

(11) "Flow Diagrams" illustrating in diagrammatic form the industrial process steps, waste flows and recovery practices.

The eleven industrial waste guides presented, cover the principal types of industries found in the Ohio River Basin. Steel mills which contribute acid pickle liquors, certain chemical plants which contribute acid and organic materials, plastic and synthetic fiber manufacturing plants and textile plants other than cotton, are notable exceptions. Information has been collected on the wastes from these classes of industry but wide variations which make each plant unique, or time limitations, have prevented presentation of this information in the form of guides. Other industries generally mentioned in industrial waste discussions are not common to the Ohio River Basin.

Uses of Guides

The Industrial Waste Guides have been of great assistance in the industrial waste activities of the Ohio River Pollution Survey, both along lines originally intended and along lines

that later developed during the course of the work. Some of the more important uses are as follows:

(1) Assistance to field engineers.

(2) Assistance in estimating strength, volume and sewered population equivalents of industrial discharges.

(3) Assistance in determining indicated remedial measures and costs.

(4) Assistance in soliciting unpublished information from engineers, chemists and others familiar with specific industrial wastes.

Sources of Information

Basic information on industrial wastes, including remedial measures, has been obtained from: (1) the published literature, (2) private communications with engineers and chemists, municipal and private, equipment manufacturers, industrial management, trade associations and others, (3) sampling and gaging results obtained in connection with the present survey, (4) field engineers' reports on routine inspections in connection with the present survey, and (5) U. S. Public Health Service files.

The review of published information has been largely confined to American publications, and European and other foreign practices are incorporated, with few exceptions, only in so far as it is reported in American literature. Important references are listed in the bibliographies of the individual guides.

Excellent co-operation and valuable information have been received through private communications from municipal and private engineers and chemists, equipment manufacturers, industrial management, trade associations and others. This information has been received as a result of written inquiry and consultation. The industrial waste guides were first issued in limited number in preliminary form and distributed to those familiar with specific industries. Comments, corrections and supplementary information received in reply have been particularly valuable. Results of sampling and gaging studies made by the Sanitary District of Chicago are worthy of special mention.

Detailed information on representative industrial plants has been secured during the present survey by co-operative arrangements with the Tennessee Valley Authority, the State of West Virginia, and the cities of Louisville, Kentucky, and Cincinnati, Ohio. Programs were co-ordinated and assistance was furnished in the cases of the Tennessee Valley Authority, the State of West Virginia and the City of Louisville. Sampling and gaging studies were made at a total of 29 industries, of which 15 were in the Tennessee Valley, 3 in the State of West Virginia, and 11 in and near the City of Louisville. Particular attention was devoted to securing information on individual discharges rather than confining activities to the total plant wastes. In the cases of Louisville and Cincinnati, rather extensive surveys were made by these cities for the purpose of designing sewage collection and treatment works for the abatement of pollution. In the case of Cincinnati, individual industries were not as a rule studied, but comprehensive sampling and gaging studies were made on all sewer outfalls, making it unnecessary for the Ohio River Pollution Survey to cover the industries individually.

Some of the best available sources of information on remedial measures now in practice are the reports of routine inspections made in connection with the Ohio River Pollution Survey. As shown on Table 2, slightly over half the industrial plants not now discharging to municipal treatment plants have already taken at least minor corrective measures to abate pollution. The detailed data has been of considerable assistance in determining indicated remedial measures, as many of the outstanding instances of industrial waste treatment are located in the Ohio River Basin.

As a result of the previous Ohio River Survey and of other studies, the Cincinnati files of the U. S. Public Health Service contain additional information on industrial wastes, particularly on the subject of strength and quantity factors.

Survey Methods

The standard procedure followed in the survey of industrial waste discharges has been by inspection and report, using a classified industry (I-1 to I-12) or the miscellaneous (I-M) "note-taking form" and the standard form of report shown at the back of each Industrial Waste Guide.

At plants that are unique, or which, by reason of products or processes could not be compared with others, it was necessary to collect samples for examination and to measure or estimate flows. Samples of individual discharges were collected at the point of creation of the waste in a number of instances. Accurate information is usually available on quantities of such discharges which are often intermittent, whereas sampling of total plant discharges diluted by cooling and other waters would necessitate careful, long-time gaging and composite sampling.

Sampling and gaging studies over periods of from two to ten days were carried out at a number of typical as well as unique industries. Special effort was made to select industries willing to furnish detailed operating data covering the period of study, so that gaging and analytical results could be correlated with plant operations.

Sewered Population Equivalents

Industrial wastes may be objectionable for a great variety of reasons. They may contain:

(1) High organic or biochemical oxygen demand content.
(2) Suspended solids.
(3) Chemicals toxic to aquatic life.
(4) Excess acid, hardness or salinity
(5) Taste and odor producing substances.
(6) Undesirable coloring matter.

Although no single measure of pollution is applicable to all of these types of industrial wastes, the biochemical oxygen demand is the most nearly satisfactory. Sewered population equivalents of industrial wastes have been based on 0.167 pounds of 5-day, 20° C. biochemical oxygen demand per capita per day.

In a few cases, sewered population equivalents based on suspended solids have been considered. Such an equivalent is of interest at industrial plants discharging or planned for discharge to municipal treatment plants, particularly of the plain sedimentation type where sludge quantities are important. Per capita contribution of suspended solids has been taken as 0.2 pounds per day.

A summary of the typical sewered population equivalent (B.O.D.) figures based on units of production is shown on Table 1.

Table 1 - Summary of Waste Discharges, Sewered Population Equivalents, and Employees per Unit of Production, with Typical Analytical Results, for Various Industrial Wastes.

Industry	Unit of Daily Production	Employees per Unit	Wastes Gal. per Unit	Typical Analyses p.p.m. B.O.D.	Typical Analyses p.p.m. Susp.Sol.	Sewered Population Equivalents (1) B.O.D.	Sewered Population Equivalents (1) Susp.Sol.	Remarks
Brewing	1 barrel of beer	0.25	470	1,200	650	19	9	Spent grain dewatered.
do	do	0.25	470	800	450	12	6	" " sold wet.
Canning								
Apricots	100 cases #2 cans	-	8,000	1,020	-	410	-	
Asparagus	do	-	7,000	100	30	35	9	
Beans, green	do	-	3,500	200	60	35	9	
" , lima	do	-	25,000	190	420	240	440	
" , pork and	do	-	3,500	920	225	160	55	
Beets	do	-	3,700	2,600	1,530	480	240	
Corn, cream style	do	45	2,500	620	300	75	30	
" , whole kernel	do	-	2,500	2,000	1,250	250	130	
Grapefruit, juice	do	-	500	310*	170*	8*	3*	* Excl. peel bin wastes.
" , sections	do	-	5,600	1,850	270	520	63	
Peaches-Pears	100 cases cans	-	6,500	1,340	-	440	-	Size of can unknown.
Peas	100 cases #2 cans	1	2,500	1,700	400	210	40	
Pumpkin (Squash)	100 cases #2½ cans	-	2,500	6,400	1,850	800	190	
Sauerkraut	100 cases #2 cans	-	500	6,300	650	100	8	
Spinach	do	-	16,000	620	-	490	-	
Succotash	do	-	12,500	520	250	330	130	
Tomatoes, products	do	-	7,000	1,000	500	350	150	
" , whole	do	6.5	750	4,000	2,000	150	60	
Coal Washery	1,000 tons coal washed	6	-	15	115,000	-	-	
Coke	100 tons of coal carbonized	8	360,000	85	-	1,500	-	Wastes cause tastes and odors.
Distilling, grain								
Combined wastes	1,000 bu.grain mashed	40	600,000	230	360	2,500	2,300	Excl.intentionally disch.slop.
Thin slop	do	-	-	34,000	-	55,000	-	
Tailings	do	-	-	740	-	50	-	
Evaporator condensate	do	-	-	1,200	-	1,500	-	
Distilling, molasses	1,000 gal. 100 proof	8	8,400	33,000	3,270	12,000	1,000	Molasses slop.
Cooling water	do	-	120,000	-	-	-	-	
Meat								
Packing House	100 hog units of kill	30	550	-	-	77*	25*	*Paunch manure to sewer.
do	do	30	550	900	650	24	14	(1 cattle equals 2½ hog units*)
Slaughterhouse	do	20	125	2,200	930	13	2	(2½ calves = 2½ sheep)
Stockyards	1 acre.	-	25,000	65	175	80	130	
Poultry	1,000 lbs. live weight	6	2,200	-	-	300	140	Av. wt. = 4.5 lbs./animal.
Milk								
Receiving Station	1,000 lbs.raw milk & cream	0.15	130	500	-	4	2	
Bottling Works	do	0.21	250	-	-	7	3	
Cheese Factory	do	0.38	200	100	750	16	9	
Creamery	do	0.16	110	1,250	660	6	3	
Condensery	do	0.47	150*	1,500	750	7	4	* Excl. vacuum pan water.
Dry Milk	do	0.39	150	450	-	5	3	
General Dairy	do	1.09	540	570	540	10	5	
Oil Field	100 bbls. crude oil.	1.3	13,000	-	-	-	-	
Oil Refining	do	3	77,000	20	50	60	120	1 bbl. = 42 gal.
Paper								
Paper Mill	1 ton of paper.	4.4	39,000	19	452	26	520	No bleaching.
" "	do	4.6	47,000	24	156	40	220	With bleaching.
Pasteboard	do	2.1	14,000	121	660	97	445	
Strawboard	do	1.4	26,000	965	1,790	1,230	1,020	
Deinking	do	-	83,000	300	-	1,250	-	Old paper stock.
Paper pulp								
Groundwood	1 ton dry pulp	2.5	5,000	645	-	16	-	
Soda	do	3.0	86,000	110	1,720	460	6,100	
Sulfate (Kraft)	do	-	64,000	123	-	390	-	
Sulfite	do	3.1	60,000	443	-	1,330	-	
Tanning, vegetable	100# raw hides	7	800	1,200	2,400	48	80	
" , chrome	do	-	-	-	-	24	40	
Textile								
Cotton								
Sizing	1,000# goods processed	-	60	820	-	2	-	
Desizing	do	-	1,100	1,750	-	96	-	
Kiering	do	-	1,700	1,240	-	108	-	
Bleaching	do	-	1,200	300	-	17	-	
Souring	do	-	3,400	72	-	12	-	
Mercerizing	do	-	30,000	55	-	83	-	
Dyeing								
Basic	do	-	18,000	100	-	100	-	
Direct	do	-	6,400	220	-	71	-	
Vat	do	-	19,000	140	-	130	-	
Sulfur	do	-	5,400	1,300	-	360	-	
Developed	do	-	14,400	170	-	120	-	
Naphthol	do	-	4,800	250	-	59	-	
Aniline Black	do	-	15,600	55	-	41	-	
Print Works	do	-	4,500	95	-	15	-	
Finishing	do	-	6	1,240	-	0.4	-	
Rayon Manufacture	1 cord wood distilled	35	690,000	30	-	1,000	-	Wood distillation process.
" "	1,000# rayon produced	64	160	44	19	35	130	Cupra-ammonia process.
" "	do	50	140	110	96	800	580	Viscose process.
" Hosiery	1,000# hose produced	-	9,000	330	-	150	-	Boil-off and dye wastes.
Silk Hosiery	do	-	13,700	1,720	-	1,180	-	Boil-off,dye, & finish wastes.
Woolen Mill	1,000# finished goods	-	70,000	114	-	400	-	Scouring & dyeing-no grease wool.
" "	do	-	240,000	125	-	1,500	-	" " " 100% " "

(1) Persons per unit of daily production.

Remedial Measures

Reduction of industrial waste pollution is generally accomplished by one or more of the following measures:

(1) Changes within the plant itself. This may involve re-use of all or part of the waste within the plant, development of by-products, changes in plant processes, or merely greater care in plant operation to reduce the amount of material discharged as waste.

(2) Treatment with municipal sewage. Many industrial wastes can be quite effectively treated in this way. It is often necessary to pretreat the waste at the source or to segregate certain portions of the wastes within the plant and exclude those from the municipal sewers to prevent damage to sewerage structures or sewage treatment processes.

(3) Treatment in a special industrial waste treatment plant. For many types of wastes, such plants employ essentially the same processes as sewage treatment plants. Other types of waste require specially developed processes. Most of the plants use the principle of sedimentation for removal of settleable solids.

The first method is usually the most economical and is one of those generally applied. It is occasionally possible to completely eliminate pollution and to recover valuable by-products, but this is not the usual situation. Ordinarily some pollution remains and some expense is involved. The second method is simplest from the standpoint of the industry. It is also the most satisfactory from the standpoint of administration of pollution abatement programs, and it reduces the number of possible sources of pollution and concentrates responsibility for effective waste treatment. It is usually necessary to make special provisions in the design of a municipal sewage treatment plant if an appreciable amount of industrial waste is to be treated. Subsequent changes in the industrial waste load sometimes cause difficulties.

The third method, treatment in a special industrial waste treatment plant, is used when the first is insufficient and the second impracticable. Segregation of cooling and other inoffensive waters for separate disposal is almost universal

practice in attacking industrial waste pollution problems. Likewise, separate collection of highly offensive concentrated materials or wastes for special attention, utilization or recovery, will often accomplish reduction in pollution at great savings over treatment costs.

In the industrial waste treatment field, chemical precipitation is popular, due largely to its ability to operate unaffected by greatly varying loads and toxic materials and to its lesser capital cost in comparison to biological processes. In those cases where removal of settleable solids is sufficient, the problem is not difficult, but satisfactory methods for the relatively complete removal of B.O.D. are available for only a few of the more common types of wastes, such as those from breweries, meat plants, milk plants and some types of canneries and distilleries. There is a pressing need for the development of more efficient and economical methods for relatively complete treatment of other types of wastes. These problems are discussed in more detail in the individual Industrial Waste Guides.

Survey Results

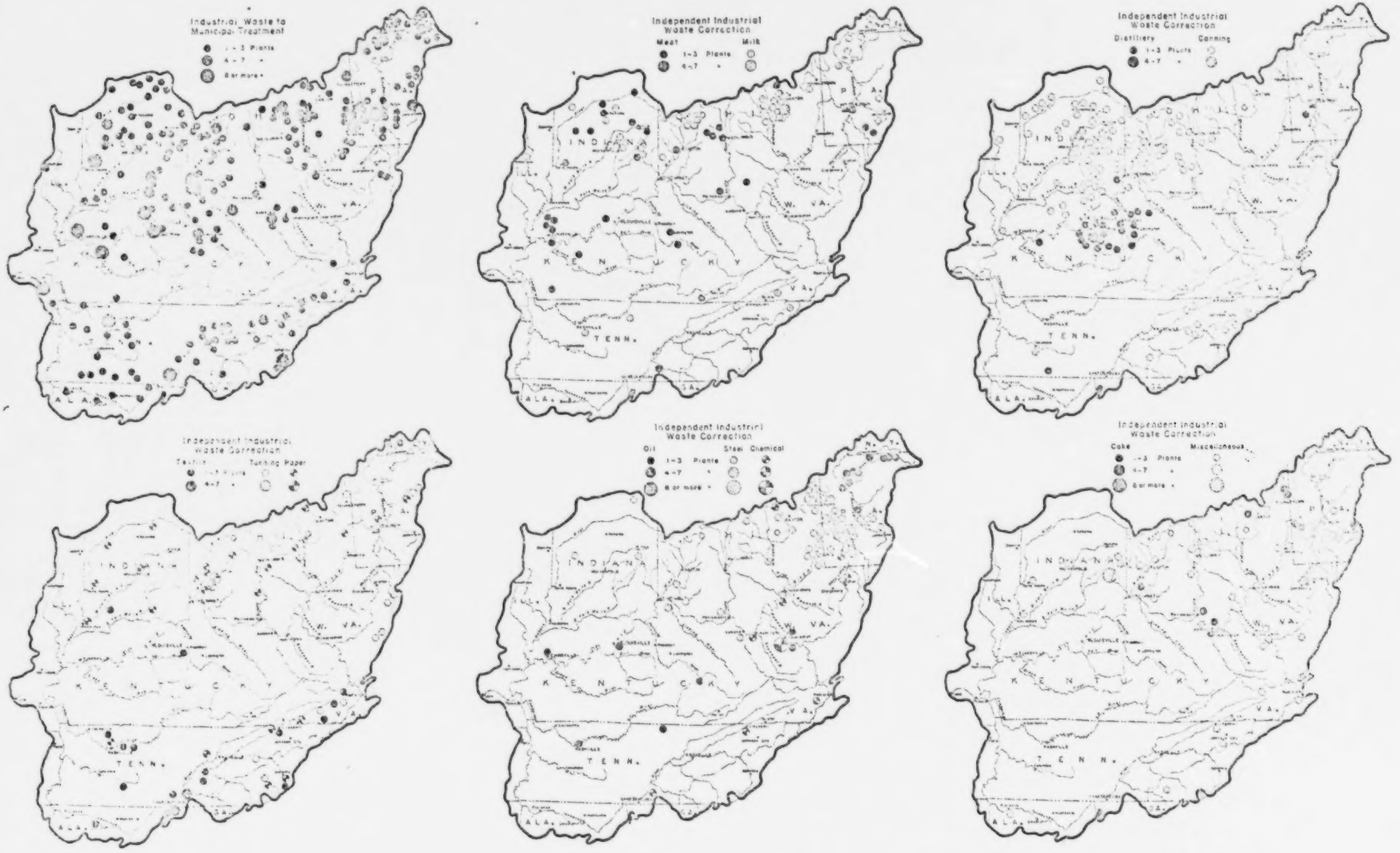
The results of industrial waste activities are presented in the individual tributary basin summaries of the Final Report of the Ohio River Pollution Survey. The magnitude of the problem of organic industrial waste is reflected in the sewered population equivalent figures. Wastes objectionable because of acid, salts, taste-producing or other characteristics are covered in discussion. Table 2 of this supplement is a repetition of Table 3 of the report proper, and summarizes data on the industrial waste pollution load of nearly 10,000,000 sewered population equivalent found in the Ohio River Basin.

Figure 1 is a repetition of Figure 12 of the report proper and shows the location of plants by industries where corrective measures are indicated. Inasmuch as the wastes from many industrial plants are now handled in a satisfactory manner, the figure does not show all plants but it indicates the areas in which industries of specific types are found.

Fig.-1

OHIO RIVER BASIN

SUGGESTED INDUSTRIAL WASTE CORRECTION



NOTE.- Exclusion of plants where present corrective measures are adequate

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OHIO RIVER POLLUTION SURVEY
U.S. PUBLIC HEALTH SERVICE
1942

Table 2 Ohio River Basin - Summary Showing Industrial Wastes not Discharging to Municipal Treatment Plants, Suggested Industrial Waste Discharges to Municipal Treatment Plants and Total of Entire Industrial Waste Load in the Basin.

Industry		Number of Plants	Industrial Waste Disposal		At Least Minor Corrective Measures Taken	Estimated Sewered Population Equivalent (B.O.D.)	Suggested to Mun. Treatment	
			Munic. Sewers	Private Outlets			Number of Plants	Population Equivalent (B.O.D.)
Brewing	See Note (1)	38	35	3	27	264,300	37	263,800
By-Product Coke		23	2	21	17	745,200	2	24,300
Canning		218	52	166	160	758,900	64	310,300
Chemical		65	10	55	36	1,880,400	8	138,000
Distilling		67	14	53	53	1,009,700	20	624,600
Meat		173	76	97	115	385,700	123	323,900
Milk		253	130	123	107	85,100	167	74,700
Oil Refining		47	4	43	44	116,500	2	15,100
Paper		59	12	47	46	1,659,200	5	31,500
Steel		174	15	159	71	(2)	12	0
Tanning		32	5	27	13	269,600	13	55,400
Textile		122	57	65	10	335,100	84	216,900
Miscellaneous		333	104	229	109	160,300	89	132,500
Total		1,604	516	1,088	808	7,670,000	626	2,211,000
Industrial Wastes to Cincinnati Sewers (3)						1,108,400	-	1,108,400
Wastes Discharged to Municipal Treatment						1,195,900	-	-
Totals for the Basin						9,974,300	626	3,319,400

(1) Note: Industries occurring only once in a basin are included under "Miscellaneous" in the basin summary but are under their proper classification in this table.
(2) 336,000 pounds free acid discharged daily in waste pickle liquor.
(3) Industries not surveyed individually. Population equivalent based on comprehensive sewer gaging and sampling program of city.

Acknowledgments

The compilation of industrial waste information and the preparation of the industrial waste guides were carried out with the collaboration and assistance of numerous state officials, engineers and chemists representing municipal and private interests, equipment manufacturers, industrial management, trade associations and others. Special mention is made of the Tennessee Valley Authority, the State of West Virginia, and the Cities of Louisville and Cincinnati, who co-operated and assisted in sampling and gaging studies of industrial wastes, or made the results of such studies available. Dr. F. W. Mohlman, of the Sanitary District of Chicago, contributed results of sampling and gaging studies of that organization.

While it is not practicable to mention here all sources of information, the bibliographies of the individual guides present comprehensive listings of information sources. The National Canners Association, the State of Wisconsin and Mr. A. E. Kimberly furnished valuable information used in the cannery guide. Mr. H. A. Trebler, of Sealtest, Inc., and Mr. R. O. Henszey, of the Carnation Co., furnished information for the milk guide. Mr. W. B. Hart, of the Atlantic Refining Co., furnished information for the oil guide. Mr. C. M. Baker furnished information for the paper guide. Officials of the States of West Virginia and Pennsylvania, and Mr. Fred O'Flaherty, of the Tanners Council of America, furnished information for the tannery guide.

Personnel

The personnel of the Ohio River Pollution Survey contributing to the compilation of information on industrial waste pollution and the preparation of the Industrial Waste Guides are as follows:

H. R. Crohurst, Senior Sanitary Engineer,
Administrative direction.

Ellis S. Tisdale, Sanitary Engineer (R),
Technical direction.

M. LeBosquet, Jr., Senior Public Health Engineer,
Immediate supervision of industrial waste activities and editing of all guides and revisions. Prepared drafts of Brewery, Distillery (coauthor) and Cannery (tomato, coauthor) Guides, and prepared revisions

of Coal Washery, Coke, Cotton and Distillery Guides for final report.

Samuel R. Weibel, Associate Public Health Engineer, Compiled the bulk of industrial waste information, assisted Mr. LeBosquet and prepared drafts of Meat, Milk, Oil, Paper (and Paper Pulp) and Tannery Guides.

William T. Eiffert, Assistant Public Health Engineer, Assisted Mr. Weibel and Mr. LeBosquet during 1940-41.

Gordon E. McCallum, Associate Public Health Engineer, Prepared drafts of Cannery (corn, tomato-coauthor, and peas) Guide.

George D. Reed, Assistant Public Health Engineer, Prepared drafts of Distillery (coauthor) and Coal Washery Guides, and supervised, for the U.S.Public Health Service,the co-operative sampling and gaging studies with the City of Louisville.

H. Gardner Bourne, Jr., Assistant Chemical Engineer, Prepared draft of Coke Guide, and assisted, for the U.S.Public Health Service, in co-operative studies with the State of West Virginia.

Ralph Porges, Assistant Sanitary Engineer (R), Prepared draft of Cotton Textile Guide.

Richard F. Poston, Associate Public Health Engineer, Supervised, for the U. S. Public Health Service, the co-operative sampling and gaging studies with the Tennessee Valley Authority.

Richard L. Woodward, Associate Public Health Engineer, Prepared revisions of Brewery, Cannery, Meat, Oil and Tannery Guides for final report.

Ralph C. Palange, Assistant Sanitary Engineer (R), Prepared revisions of Milk and Paper Guides for final report.

Note: Official designations apply to the last day of each person's connection with the Ohio River Pollution Survey.